PERSPECTIVES

Connecting Students to Content: Student-Generated Questions

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Abstract: Students learn best by being actively engaged in the learning process. This essay describes a teaching technique where students generate their own questions about a course topic. This occurs at the beginning of each new section of a course. The instructor works with the class to answer the students' own questions throughout that section of the course and, via discussion and research, students become better connected and more motivated to learn the content as the course continues. This technique has been used successfully in several different biology courses including anatomy, physiology, environmental biology and introductory biology. Try it. You might like it!

Key words: student-generated questions; course content; student engagement; active learning

One of the biggest challenges of teaching any biology course is to get students to see the relevance, the connections, and the applications of course content using their previous knowledge from other courses and from everyday learning experiences. When students can see and understand these connections, their motivation to learn and add to their stored knowledge is enhanced. (Barkley, 2010)

Another challenging aspect of active student learning is to promote vocal student discussions and question/answer sessions in class. Many students feel uncomfortable talking in a group or contributing to these discussions. But if a specific compelling statement or topic is discussed, especially if they generated it themselves, students may "come out of their shell" and contribute their ideas and benefit their learning directly (Ambrose et al., 2010).

More learner-centered instruction and less teacher-centered instruction is another somewhat recent movement that has been shown to increase student learning and motivation to learn in many classrooms. Students are invited to have more input in planning the direction and content discussed in class. Sometimes they are asked during the first week of class to help decide the weight of assignment grades and even the basic content of exams. The more connections and engagement they have, the better they will learn new information. Studies have shown that more student ownership of the course and its content result in better retention and better application of information after the course (Weimer, 2002; Blumberg, 2009).

To try to better connect students to the content of many of my courses and meet some of these challenges, I use the following teaching method. When I start a new topic, I ask students to generate their own questions about the topic. A topic is usually a different body system in anatomy and physiology or a new text chapter in environmental biology. I give them 10 minutes to talk with their neighbor, open their text or do a quick Google search on their laptop or smartphone about the upcoming topic that the class will explore in the next several weeks. I use prompts to get them started like asking about rumors, myths, or stories they have heard about or ads they have seen on TV or the internet. I mention a few new terms or diseases they may have heard of to get them thinking. What have they heard about this topic in other classes, in the cafeteria, on the street, or at their relative's house about this topic?

Table 1. Cardiovascular/Heart Questions

Effects of aerobic training on heart health? How much training for how long?
Mitral valve transplants? Are pig valves really used? How?
Artificial valves and blood thinners? Why? What do blood thinners do? Effects of "thin blood"?
Why do some people have higher susceptibility to high BP? What do BP medications actually do?
Heart murmur – genetic or can it get worse with age?
Cold hands/cold feet – poor circulation? Long term effects?
Hole in one's heart – surgery or not?
Do taller people's hearts work harder?
How does my heart work continuously and not fatigue?
Why can young people have heart attacks?
Heart attack vs. stroke?
Heartworm? In people or just dogs? Why?
Tingly feeling when foot or arm falls asleep?

Table 2. Respiratory Questions

Why do lungs fill with fluid when sick? Pneumonia?
Why does my throat feel tight when you exercise?
Is there a better way to breathe when running – through the nose or through the mouth?
Is asthma genetic? What happens during asthma attack? Sports induced asthma?
How does an inhaler work?
Why do lungs collapse?
Why do swimmers hyperventilate before certain swimming events?
How do oxygen tents work? NFL and NBA players using them – benefits? Problems?
Does taking protein supplement affect lungs?
Can I still exercise with a respiratory illness?
Breathing oxygen-carrying liquid into lungs? Possible? Problems?
Popping noises when exhaling when congested?
How long after quit smoking do lungs improve? Will lungs always be damaged?
Why do lungs burn when running outside in cold?

Are there diseases related to this topic or everyday questions they would like to learn more about? I ask them to write at least two questions first. Then they look at their neighbor's questions to see if they had any common interests. Finally, I make a list of questions on the board as they ask them.

Sometimes during this question-recording time, class discussions erupt about where students heard certain information or comments like "that same thing happened to me." Genuine looks of interest come over many faces as these questions emerge. Truthfully, despite over 20 years of teaching these courses, many new interesting questions arise each semester for each topic, ones that I would have never thought to ask or include in the class activities for that topic. Some questions are simple and some come from very individual experiences. Some students almost seem relieved that, finally, they get to pose their own question – not just something that the instructor thinks is important! I collect all the written questions from each student and make a large list for that topic. I keep this list available during my talks, after student presentations and in labs. I try to remember to have the class help me answer a few of them each day, especially when the specific information for that day connects directly to several questions on the list.

I teach a majors physiology course, a non-majors general education A&P course and an elective, cadaver-based, human anatomy course. In all three courses, I have successfully started each new topic/system by having students generate a list of their questions for which they would like to learn answers. Questions and answers become parts of exam questions for that topic. Many times, questions from the list are posed to four or five students at the end of a class period. They find answers, working individually or in small groups, and bring them back to the next class period for everyone to learn. Having different groups of students find answers to the same questions sometimes produces controversy or added depth to the discussion of answers in the subsequent class period. When groups present different answers to the same question, this adds intrigue and increases students' motivation to find out more and check the credibility of the sources of both sets of answers. This immerses students into the process of science even more, as they practice their abilities to be skeptical at all times – an important characteristic of being an active scientific citizen.

I prepare for these answer sessions by having electronic images or websites available that show details of the disease in question, or pros and cons of a specific treatment or concept. During the review

Table 3. Muscle Questions

Pulled muscles? How do they fix themselves? Repair process? Can muscles be retrained after surgery?
Muscular Dystrophy – Cure in future? Why do they have increased bronchitis, pneumonia easier?
Slow twitch ←→ Fast twitch conversion? How do I know if I have slow or fast twitch fibers?
Muscle strength limits? Muscle size limits?
Able to transplant muscles like organs?
Lifting causes microscopic tears – able to use stem cells to make muscle repair bigger and faster?
How does electric stimulus machine cause muscle to contract? Benefits? Problems?
Irregular huge strength at times of danger?
Most important nutrients for healthy muscles?
Calcium deficiency affect sliding filament theory?
Why do they feel like jello after done running?
How do people lose muscle over time? Why?
Why is it easier for some people to build muscle than others?
Is protein safe to take?
Barry Bonds – "the cream" and "the clear"?
Differences between muscles in men vs. women?
Can muscles be retrained after surgery?

Table 4. Cancer Questions

What factors can speed up or slow down treatment effects besides medications?
Cancer killed by Vitamin B17?
Do things I eat or chemicals/hormones added to food cause cancer?
Does it skip generations?
Why are nerve endings so active right before death?
Do cell phones cause cancer?
Why do some forms of cancer spread faster than others? How does it spread? And how fast?
How do I help someone going through treatment? Exercise, healthy diet?
Why do some people with same cancer respond differently to same treatment?
Two people could smoke entire life but one dies of cancer, the other not. Why?
Which water bottles give you cancer?

session for the topic before an exam, I review the list of student questions and ask them for the answers that they remember. Sometimes we get questions for which we cannot find adequate, well-documented answers. Students learn that many questions in science and everyday life do not have good answers yet. Some find this hard to believe and others keep trying to find a better answer. I encourage students to constantly ask questions, to be curious, to stop and find answers when they can. Science and understanding the world around us is driven by asking questions, finding answers and satisfying oneself about the application of new answers in everyday life. I have included several actual lists of questions from several commonly explored topics in my courses (Tables 1-4) to show the variety and unexpected nature of questions students have asked.

I have successfully used this method in my anatomy and physiology courses because students are interested in their own bodies and in how diseases affect them, their relatives or friends. Can this method work in other biology courses… in a cell biology course, a microbiology course or an introductory biology course? Yes, I am confident that it can. I have used it successfully in several environmental biology courses. Topics like drinking water, ground water pollution, storm water runoff, land use, air and soil pollution, and invasive species are all topics that most students have heard of or witnessed personally that help them generate questions. With the use of specific prompts as noted earlier, and giving students time to look through their textbooks, talk to their classmates or search for basic information, they can successfully frame a solid question or two. Many times, as questions start being asked, this stimulates thinking and prompts other students to ask related questions.

Overall, this method greatly helps connect students to a topic and its applications to everyday life. In my experience, I think students possibly learn more as they wait for the answers to their questions to be discussed. This stronger connection to the topic can also help them remember it better. One of the aspects of how students learn effectively is by connecting new or current information to previously learned information (Barkley, 2010). This helps build a bigger, broader, overall "mind map" for that topic and its applications. I encourage other biological educators to try this method in their courses. It has helped to better connect my students to course content, increased their motivation to learn, and given me the opportunity to learn more along with my students.

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